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SOLUTION BY R. D. CARMICHAEL, Indiana University.

The equation may be written in the form

$$\frac{\partial}{\partial v}\left(\frac{\partial T}{\partial u}+\frac{2u}{u^2+v^2+1}T\right)+\frac{2v}{u^2+v^2+1}\left(\frac{\partial T}{\partial v}+\frac{2u}{u^2+v^2+1}T\right)=0.$$

This equation may be viewed as an ordinary differential equation for determining the quantity in parenthesis; the arbitrary "constant" is then a function of u. Solving this equation, we have

$$\frac{\partial T}{\partial u}+\frac{2u}{u^2+v^2+1}T=\frac{\bar{\psi}(u)}{u^2+v^2+1};$$

or

$$(u^2+v^2+1)\frac{\partial T}{\partial u}+2uT=\bar{\psi}(u).$$

Hence

$$(u^2+v^2+1)T=\int\bar{\psi}(u)du+\varphi(v)=\psi(u)+\varphi(v).$$

Therefore, we have

$$T=\frac{\psi(u)+\varphi(v)}{u^2+v^2+1},$$

where $\psi(u)$ and $\varphi(v)$ are arbitrary functions of u and v respectively.

Solved in a different manner by the Proposer.

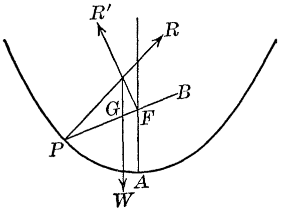
MECHANICS.

267. Proposed by G. H. LIGHT, Purdue University.

A parabolic curve is placed in a vertical plane with its axis vertical and vertex downwards, and inside it, and against a peg in the focus, and against the concave arc, a smooth uniform and heavy beam rests; required the position of equilibrium. [From Bowser's Mechanics, Ex. 37, p. 96.]

SOLUTION BY CHRISTIAN HORNUNG, Heidelberg University, Tiffin, O.

Let PB be the beam of length l, of weight W, resting on the peg at the focus, F; let $AF=p$, $AFP=\theta$, and $GP=l/2$. From the polar equation of the parabola we have $FP=2p/(1+\cos\theta)$.



Since all the surfaces are smooth the resistances, R and R', at P and F respectively, are normal and therefore the angle $BPR=\theta/2$.

Using the equations $\Sigma x=0$, $\Sigma y=0$ and Σ(moments about F) $=0$, which express the conditions of equilibrium, we have respectively:

$$R\sin\frac{\theta}{2} - R'\cos\theta = 0, \qquad R\cos\frac{\theta}{2} + R'\sin\theta - W = 0,$$

$$R\left(\frac{2p}{1+\cos\theta}\right) - W\left(\frac{2p}{1+\cos\theta} - \frac{l}{2}\right) = 0.$$

From these three equations we get

$$\cos^4\frac{\theta}{2} = \frac{p}{l}, \qquad \cos\frac{\theta}{2} = \left(\frac{p}{l}\right)^{\frac{1}{4}}, \qquad \theta = 2\cos^{-1}\left(\frac{p}{l}\right)^{\frac{1}{4}},$$

which is the result given as the answer to the problem by the author.

Excellent solutions were received from M. E. Graber, E. B. Escott, J. E. Sanders, J. Scheffer, A. M. Harding, M. J. McCue, Mrs. H. E. Trefethen, S. G. Barton and the Proposer.

NUMBER THEORY AND DIOPHANTINE ANALYSIS.

193. Proposed by W. E. HEAL, Washington, D. C.

Develop a formula for the value of x in the equation $p^x + q^x = s^x$, p, q, and s being integral numbers.

Solution by B. F. Yanney, University of Wooster.

By letting $a = p/s$, $b = q/s$, the given equation may be reduced to the form

$$a^x + b^x - 1 = 0.$$

Setting $y = a^x + b^x - 1$, and remembering that

$$a^x = 1 + x\log_e a + \frac{x^2\log_e^2 a}{2\,!} + \frac{x^3\log_e^3 a}{3\,!} + \cdots,$$

we have

$$y = 1 + x\log_e(ab) + x^2\frac{\log_e^2 a + \log_e^2 b}{2\,!} + \cdots.$$

By reversion, we get

$$x = A(y-1) + B(y-1)^2 + C(y-1)^3 + D(y-1)^4 + \cdots,$$

where

$$A = \frac{1}{\log_e(ab)}, \qquad B = -\frac{\log_e^2 a + \log_e^2 b}{2!\log_e^3 a},$$

$$C = \frac{2\cdot 3!\,(\log_e^2 a + \log_e^2 b)^2 - (2!)^2\log_e(ab)\cdot(\log_e^3 a + \log_e^3 b)}{(2!)^2 3!\log_e^5 a},$$

$$D = -\{5\cdot 3!\,4!\,(\log_e^2 a + \log_e^2 b)^3 - 5\cdot(2!)^2 4!\log_e(ab)\cdot(\log_e^2 a + \log_e^2 b)(\log_e^3 a + \log_e^3 b) + (2!)^3 3!\log_e^2(ab)\cdot(\log_e^4 a + \log_e^4 b)\} \div \{(2!)^3 3!\,4!\log_e^7 a\},$$

etc.

Now, by hypothesis $y = 0$.

Hence

$$x = -A + B - C + D - \cdots.$$

Also solved by A. H. Holmes. Mr. Yanney sent a solution of 188 after the list of solutions was sent to the printer.